The new elements, based on these data, are as follows :—

Maximum = J.D. 2396 168·738 } (M.T. Paris) + 7·176382 E.
Minimum = J.D. 166·365 } + 0·14 sin (0°·044 E. + 304°)

or

	d.	h.	m.	s.		d.	h.	m.	s.	
Maximum 1848 May	20	17	42	43	+	7	4	13	59·4	E.
Minimum ,, ,,	18	8	45	36	+	202m. sin (0°·044 E. + 304°)				

and a comparison of the weighted means of his own and other observations leads M. Luizet to the conclusion that the interval between the principal and secondary maxima is 2·373 days, or 2d. 8h. 58m. (*Astronomische Nachrichten*, No. 3911).

ABSORPTION OF STAR LIGHT BY COMET 1903 *c*.—Prof. Max Wolf publishes, in No. 3914 of the *Astronomische Nachrichten*, two photographs of comet 1903 *c* taken on July 25 when the comet was passing in front of the 6·5 magnitude star B.D.+63°.1056. On comparing these photographs with the observations of comet 1902 III., Prof. Wolf arrives at the conclusion that the later comet exhibited a selective absorption of star light which was not exhibited by the earlier one.

PUBLICATIONS OF THE PULKOWA OBSERVATORY.—Vol. x. (2nd series) of the *Publications* de l'Observatoire Central Nicolas, edited by M. M. Nyrén, contains the details of the observations made with the prime-vertical transit instrument from 1869 to 1896. In the introduction, M. Nyrén discusses very minutely the errors of the instrument and their corrections, paying particular attention to the causes which might produce a small yet persistent residual as yet unaccounted for.

The results were analysed in order to test the validity of Chandler's " $\Delta\phi$ " term for the variation of latitude, and they indicate that that observer's empirical formula requires some slight modification, although M. Nyrén hesitates to make a definite statement on this point. The constant of aberration as deduced from these observations is 20″·4423 if Chandler's term be considered; without the latter the value is 20″·4451, and M. Nyrén observes that, in the mean, this term seems of small importance.

In vol. xiii. of the same *Publications* M. Nyrén publishes a new catalogue of 1336 reference stars situated between dec. −30° and dec. +90°. This differs from Struve's Pulkowa catalogue in only containing stars between magnitudes 5 and 7; at least this was the original proposal, but it has been found necessary in practice to admit others which are just outside these limits. The idea of this selection was to include stars which were faint enough to give exact readings, and not too faint to be observed with the vertical circle used. Another feature of the catalogue is the division of the zone into squares, of which each side is 5° in length, and the observation of only one star in each zone, thus ensuring the even distribution of the reference positions without incurring too great a labour in the observations. The section of the zone −15° to +90° was observed at Pulkowa, and stars selected from the Bonn Durchmusterung were used, whilst the remaining section was observed at the subsidiary observatory at Odessa, where the Cordoba catalogue was used. Details of each observation made are given in the catalogue, and, together with the results, they occupy 487 quarto pages.

GUIDE FOR ASTRONOMICAL AND GEODETICAL CALCULATIONS.—Part ii. of Signor J. Boccardi's " Guide du Calculateur " will be found to be an extremely useful reference book by all who desire to perform calculations of observational results in astronomy or geodesy. It gives lucid explanations of many typical computations, such as the calculation of precessional effects, reductions to apparent place, elements of orbits, the determination of an orbit from three observations, and the special perturbations of an orbit; it also explains and illustrates the method of " least squares." Under the heading of " Geodesy " the solutions of many typical problems are explained and examples worked out, several special methods being named and clearly elucidated. Numerous worked examples are given throughout the book, each problem and method being clearly illustrated in this manner. The work is published by M. A. Hermann, 6 Rue de la Sorbonne, Paris.

THE EDISON ACCUMULATOR.[1]

MR. W. HIBBERT read a most interesting paper on the Edison accumulator before the Institution of Electrical Engineers last week. Since the first announcement of Mr. Edison's invention nearly three years ago, very little of an authoritative nature has been published about the cell; the paper which Dr. Kennelly read in May, 1901, showed that the invention was full of promise, and further results of more extensive experiments and of practical trials have since been awaited with eagerness. A description of the cell itself was published in NATURE in July, 1901 (vol. lxiv. p. 241), and as it has undergone little alteration since then we need not describe it in detail here; the active materials, it will be remembered, are nickel oxide and iron, and the electrolyte is a 20 per cent. solution of caustic potash; the chemical changes on charge and discharge may be represented by the equation

$$\underset{\text{After charge}}{NiO_2 \,|\, KHOaq \,|\, Fe} \rightleftarrows \underset{\text{After discharge}}{NiO \,|\, KHO.aq \,|\, FeO},$$

the electrolyte serving merely as an oxygen carrier, and not taking any actual part in the final changes of the active material, as does the sulphuric acid in the lead-lead-peroxide cell. The active materials are packed in perforated steel pockets, and the plates, though thin, are rigid and light. The construction is thoroughly mechanical throughout, and the lightness is obtained without any sacrifice of durability,

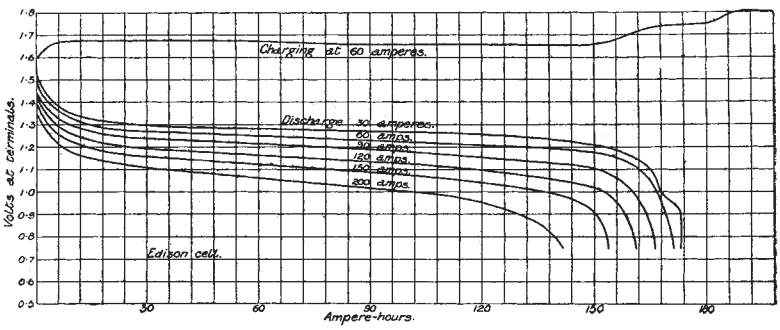

FIG. 1.—Discharge Curves of Edison Cell. From the *Journal* of the Institution of Electrical Engineers.

which is one of the chief faults of the lighter types of lead cells. The standard size of automobile cell is 13 inches high (over all) and 5·1 × 3·5 inches horizontally. The weight is 17·8 lb. The E.M.F. is approximately 1·35 volts, and the internal resistance 0·0013 ohm; the output at 60 amperes discharge is 210 watt-hours, the capacity working out, therefore, at 11·8 watt-hours per lb. This figure agrees very closely with those which were published originally; Dr. Kennelly put the output at about 14 watt-hours per lb., and, in the article referred to above, we calculated from a discharge curve which had been published an output of 10 watt-hours per lb. The lightest lead cells in some instances approach, or even exceed these figures, but on the average the result is considerably better than that obtainable in practice with lead accumulators. It will be seen, however that in many other respects the Edison cell promises to prove much superior, especially for motor-car work.

Mr. Hibbert's tests were made partly under laboratory conditions and partly on the road. The discharge curves reproduced in Fig. 1 were taken in the laboratory, and show that the Edison cell possesses in a remarkable degree one very desirable characteristic, namely, that of giving a good output in ampere-hours when discharged at heavy discharge rates. Taking the normal discharge current as 30 or 40

[1] "The Edison Accumulator for Automobiles." By W. Hibbert, Abstract of paper read before the Institution of Electrical Engineers. November 26.

amperes, the curves show that more than 80 per cent. of the normal ampere-hours can be obtained when discharging at so high a current even as 200 amperes. A lead cell under similar conditions would probably not give more than 50 per cent. of its normal output. Experiments on the road showed that this result could be obtained under practical conditions. A 32 mile run was made from Leicester to Northampton against a head wind all the way; on the level the current varied from 55 to 60 amperes, as against the usual 40; uphill it was from 90 to 100 amperes, and on one occasion rose above 150 amperes. The total discharge came out as 190 ampere-hours, the normal standing discharge being 160 ampere-hours. The battery had been fully charged before the start, 242 ampere-hours having been put in in 1 hour and 20 minutes. This particular case shows that there is an extra discharge—30 ampere-hours in this instance—which can be got from the cell; it is due to the fact that the voltage at the end of the discharge does not continue to drop rapidly as shown in the curves in Fig. 1, but, when it has fallen to about half a volt, becomes steady again for another hour. There is, in consequence, a reserve of capacity which, though not generally used, may prove very valuable in emergencies such as the above.

Some other results obtained by Mr. Hibbert may be quoted. A cell after being short circuited for 48 hours recovered its original capacity after two charges, and was apparently none the worse for this severe treatment. Experiments on the rate of charging were tried, and showed that high charging currents can be safely used. A fully discharged cell was recharged for an hour at 177 amperes; 124 ampere-hours, or 70 per cent. of the charge, were obtained on discharge at 60 amperes. Experiments on the road confirmed this result, 70 per cent. of the charge being obtained after charging at 200 amperes. The efficiency of the cell is not quite so good as that of a lead cell; the following figures were obtained under different conditions:—at 30 amperes charge and discharge 66 per cent., at 60 amperes 60 per cent., at 100 amperes charge and 60 amperes discharge 56 per cent., and at 177 amperes charge and 60 amperes discharge about 50 per cent. On the other hand, the cell endures a period of rest before discharge well, and also does not suffer if allowed to stand discharged for some time. If discharged immediately after charge a somewhat large discharge is obtained, but after two days' rest a discharge of 155 ampere hours is given; a further twenty-four days' rest only had the effect of diminishing the discharge to 125 ampere hours, or 80 per cent. of the discharge after the two days' rest.

The trials on the road were made in a runabout with a battery of 38 cells, weighing about 700 lb.; the total weight, with two persons, was about 2000 lb. The trials were planned to afford answers to the following questions:—

(1) Is the capacity the same on the road as in the laboratory?

(2) Will the battery stand excessive discharges on the road?

(3) Will it take a rapid charge and utilise it on the road?

(4) Will it recover after lying discharged for some time?

(5) Does the capacity fall off by reason of the shaking?

(6) What attention is required?

The experiments which we have already quoted show that the answer to the first four questions is in the affirmative. With regard to the fifth question, the results were very satisfactory. The car had run 400 miles before Mr. Hibbert took it over; its capacity was then 159 ampere-hours on standing discharge. Mr. Hibbert ran it in all 500 miles in the course of a month, and at the end of that time the capacity on standing discharge was 158 ampere-hours, showing, therefore, no appreciable deterioration. As regards attention, Mr. Hibbert found very little to be required; none of the terminals worked loose or showed signs of getting unduly warm with the heavy charging currents sometimes used. The only matter that had to be attended to was the replenishing with distilled water which was required after every five or six charges.

The general results of Mr. Hibbert's tests are most encouraging; the only point on which further information is required is durability, but all the evidence is in favour of this proving satisfactory. It certainly seems as if the hopes aroused by Dr. Kennelly's paper are within measurable distance of realisation. M. S.

THE UNITED STATES GEOLOGICAL SURVEY.

WE have received parts i. to iv. of the twenty-second annual report of this survey for 1900–1. In part i., after the administrative report by Mr. C. D. Walcott, the director, there is an elaborate essay on the asphalt and bituminous rock deposits of the United States. The author, Mr. G. H. Eldridge, points out that while sandstones are storage reservoirs for mineral oils or bituminous deposits, limestones may be the place of origin as well as the means of storage. Ozocerite has been formed in some strata by the draining of petroleum pools or of strata richly saturated in oil. The author instances a reservoir in California that rests on granite, and has been filled from overlying deposits.

In part ii. ore deposits are dealt with. There is an account of the tungsten mine at Trumbull, Conn., and it is mentioned that wolframite is produced by alteration of scheelite through replacement of its calcium by iron and manganese. The ore deposits of Rico Mountains comprise galena, often argentiferous, sphalerite or zinc blende, chalcopyrite and magnetite; those of the Elkhorn district include argentiferous galena and gold, and the metalliferous deposits are believed to have been derived from igneous rocks (gabbro) lying beneath limestones, through the agency of uprising hot siliceous waters. The Blue Mountains of eastern Oregon comprise, near Baker City, an important gold-field. The mountains consist of cores of older rocks with Tertiary rhyolites, andesites, and basalts. Gold and silver occur in veins in the older rocks, and gold occurs also in placer deposits. In Monte Cristo, Washington, there are ores of copper, lead, zinc and arsenic. The lead and zinc mines of the Ozark region are dealt with in considerable detail, with respect to the relation and to the concentration of the ores, whether by ascending or descending waters. The original precipitation of the metals is traced back to the agency of organic matter, aided by concentration and evaporation in shallow seas, such as characterised the dolomitic beds of Cambro-Silurian age. Analyses show minute, but important, amounts of zinc and lead in the pre-Cambrian, Cambro-Silurian and Carboniferous rocks. The workable ores have been deposited in the fractured and brecciated areas of Carboniferous Limestone. The author discusses the chemical processes which have led to the deposition of these ores; these have in succession been oxidation of sulphides, transportation as sulphates, and precipitation in the crevices of the rocks as sulphides. Some of the ores have since been superficially changed to carbonates.

Part iii. deals with coal, oil and cement. There are statistics relating to the coal-fields of the United States, particulars about the anthracite coal-field of Pennsylvania, with its disturbed, vertical and overturned coal, and descriptions of various other coal-fields, and of the Gaines oil-field of Pennsylvania. Accounts are given of the Portland cement industry in Michigan, and of the manufacture of hydraulic cement in south-west Arkansas, where chalk comparable with that of England is used.

Part iv. deals with hydrography, with stream measurements, the hydrography of the American isthmus, and of the high plains.

We have received also part i. of the twenty-third annual report for 1901–2. It contains the report of the director, Mr. C. D. Walcott, who describes the methods of work, and appends a memoir, with portrait, of the late Clarence King.

In addition we have received a preliminary report on the Ketchikan mining district of Alaska, by Mr. Alfred H. Brooks, who deals with the gold-bearing properties and with certain silver and lead deposits; and a reconnaissance of the north-western portion of Seward Peninsula, in Alaska, by Mr. A. J. Collier, with reference to the more important gold-fields. These reports, which are naturally somewhat sketchy, will be of service to those who contemplate mining enterprises in the districts.

Two monographs of the Geological Survey have recently been published. Monograph No. xlii. is on "The Carboniferous Ammonoids of America," by Mr. James Perrin Smith. The writer tells us that he makes "no distinction between goniatites and ammonites, because there is none that will hold." He remarks that while nearly all the characteristic